

Soybean Utilization

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3 Processing of Soybeans

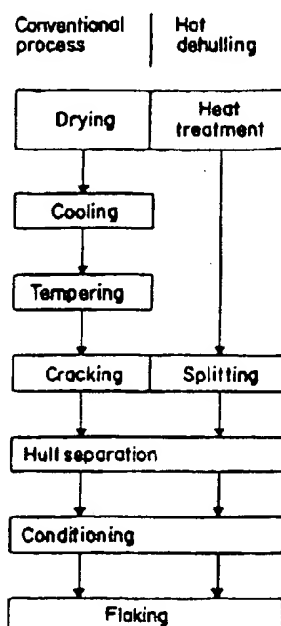


Fig. 3.7. Comparison of conventional and hot dehulling of soybeans. The initial heat treatment and conditioning are done in fluidized beds. Source: Fetzer (1983).

immediately. Again there is a saving of time and energy. The process outlined in Fig. 3.8 is termed MIVAC (microwave vacuum).

FLAKING

The conditioned meats are fed directly to flaking mills, which for soybeans are smooth rolls, placed horizontally, with pressure maintained by heavy springs between the two rolls (Fig. 3.9). The size of these rolls is approximately 30 in. (70 cm) in diameter and 48 in. (120 cm) in length. This single flaking step produces soybean flakes about 0.01–0.015 in. (0.025–0.037 cm) in thickness.

Making thin flakes of the soybean meats in preparation for solvent extraction serves several purposes. These flakes make suitable beds, even when several feet thick, through which solvent can readily flow. The same flow-through capability would not be possible with fine particles. The crushing and shearing action of the flaking rolls tends to disrupt intact cotyledon cells and this disruption may (but this is not certain) facilitate solvent penetration to the lipid bodies.

A frequently used statement in descriptions of soybean flaking is "flaking disrupts the oil cells." This is difficult to interpret, because it might mean that

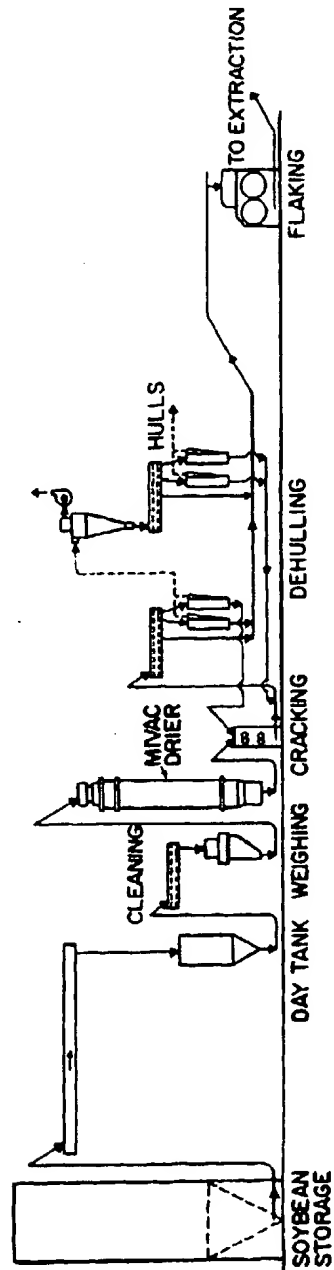


Fig. 3.8. MIVAC preparation procedure for soybeans. Source: Moore (1983).

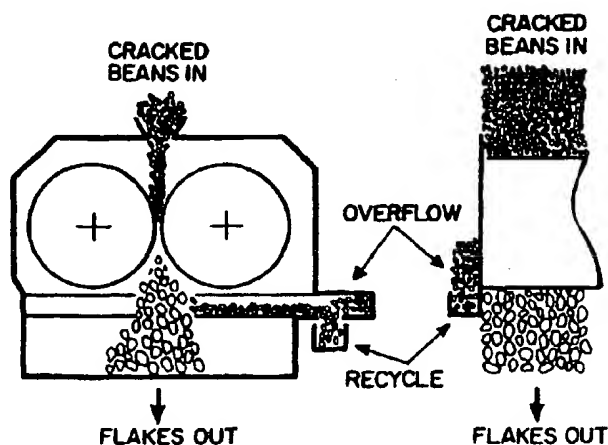


Fig. 3.9. Flaking rolls and overflow system. Source: Moore (1983).

only some cotyledon cells contain oil, and these oil cells are disrupted, or that there might be subcellular "cells" of oil that are broken by flaking. Neither of these ideas is true. As described in Chapter 2, all the cotyledon cells are rich in oil, which is contained in submicroscopic particles called lipid bodies.

A final advantage of flaking is to reduce greatly the distance the solvent and miscella (solvent-oil mixture) have to travel to complete the extraction process. The influence of flake thickness on extraction of soybean oil is shown in Fig. 3.10. As flake thickness increases, there is a very pronounced increase in the time needed to decrease residual oil to 1%. The role of flake thickness and other factors on solvent extraction of soybean oil will be discussed in more detail when we consider the various theories of solvent extraction.

Flaking rolls demand a lot of attention in preparation of soybeans for solvent extraction. The rolls tend to wear in the center more than at the ends, and this makes the production of uniformly thin flakes difficult. The tension on the springs has to be adjusted frequently, and periodically the rolls have to be reground, so that their surfaces meet. A newly introduced system of overflowing soybean meats at the ends (Fig. 3.9) and recycling helps to give uniform wear to the entire length of the flaking rolls.

A new idea in preparing soybeans for solvent extraction is to feed the flakes into an extruder to produce a material that has better extraction and solvent drainage characteristics than the flakes (Bredeson 1983). The extruder (called an "enhancer" in this instance) is a worm screw inside a solid barrel, which produces high temperatures and pressures. The flakes, after adding moisture to 18%, are extruded. Upon leaving the extruder, the sudden drop in pressure causes some expansion or puffing of the material to produce the desirable extraction and solvent drainage characteristics. Excess moisture has to be removed, and the

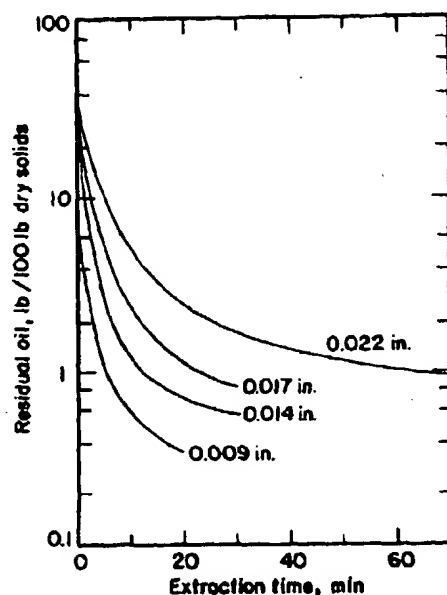


Fig. 3.10. Relation of flake thickness to extraction rate in the solvent extraction of soybean flakes by percolation with hexane. Source: Norris (1982). Copyright by Wiley, Inc.

material is cooled to 140°F (60°C) before solvent extraction. The capacities of the solvent extraction equipment and the desolventizer-toaster are increased with this kind of pretreatment. That advantage has to be weighed against the cost of the extruder and equipment needed for subsequent drying and cooling.

EXPELLERS

The predominant process in Western Europe and the United States for extracting oil from soybeans is by means of solvents. But before discussing that process, we must mention expellers that can also remove oil from oil seeds. For the thousands of small oil extraction plants throughout the world that may need to handle a variety of oil-bearing seeds, expellers are preferred.

Expellers, also called screw presses, consist of a shaft with an attached interrupted worm gear that rotates within a cage (a series of metal bars separated by small openings). As the material to be extracted is introduced at one end of the expeller, it is subjected to high pressures between the edges of the worm gear and the cage. This pressure forces oil out of the material, and the oil flows laterally between the cage bars as the press cake moves parallel to the shaft. Figure 3.11 shows several possible worm arrangements, and Fig. 3.12 shows a two-stage expeller. The first stage is vertical with material being fed by an augur, and the